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January 15, 2020

U.S. Environmental Protection Agency
Office of Ecosystem Protection
EPA/OEP NPDES Applications Coordinator
5 Post Office Square - Suite 100 (OEP06-03)
Boston, MA 02109-3912

Ref: Gris WWTP Annual Compliance Report

To Whom it May Concern:

On behalf of Barnhardt Manufacturing Company, the following report is provided as required by NPDES Permit No. MA0003697 Part 1.B.2 to detail progress towards meeting the final permit limits for phosphorus, copper, and toxicity. A three-year compliance schedule for these parameters was provided. Compliance with the limits for these parameters is required by February 28, 2021.

Phosphorus

Currently, Barnhardt is required to only report effluent total phosphorus concentrations. However, the seasonal limit of 1.26 mg/L for May through October will be in effect at the end of the compliance period.

Influent and effluent total phosphorus (TP) concentrations are shown in Figure 1. Data used are shown in Appendix A. The average influent TP concentration was 5.26 mg/L and the average effluent concentration was 3.15 mg/L. Effluent TP and orthophosphate (PO_4) concentrations are shown in Figure 2. It is observed that on average, 92% of the effluent TP is soluble PO_4. Since PO_4 is amenable to precipitation using aluminum salts, laboratory trials were conducted to determine phosphorus removal using alum, aluminum chlorohydrate (ACH), and polyaluminum chloride (PAC). The results are shown in Table 1 and Figure 3. Alum appeared to be the most effective. At a dosage of 200 mg/L, both TP and PO_4 were reduced well below the permit limit with values <0.1 and <0.023 mg/L, respectively.

In addition to treatment alternatives, work was done to identify chemicals used in manufacturing that contained phosphorus. The only chemical found to contain significant amounts of phosphorus was a boiler treatment chemical. This chemical was replaced in mid-August 2019.

Figure 1. Influent and Effluent Total Phosphorus Concentrations

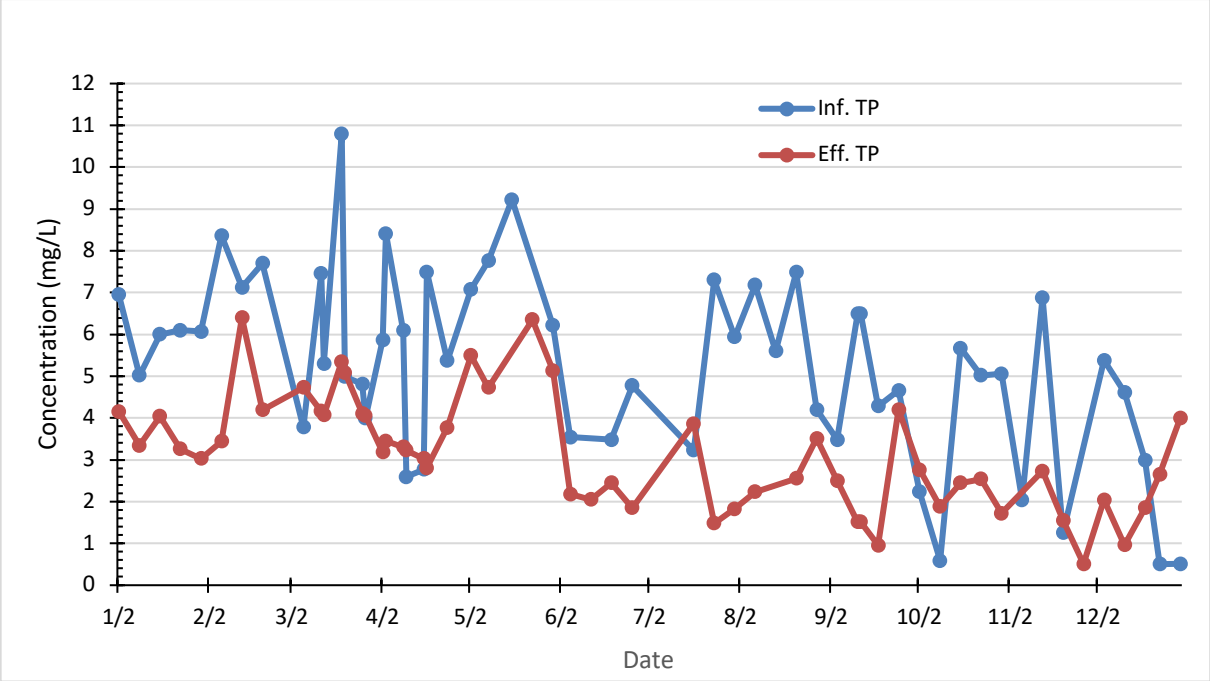


Figure 2. Effluent Total Phosphorus and Orthophosphate Concentrations

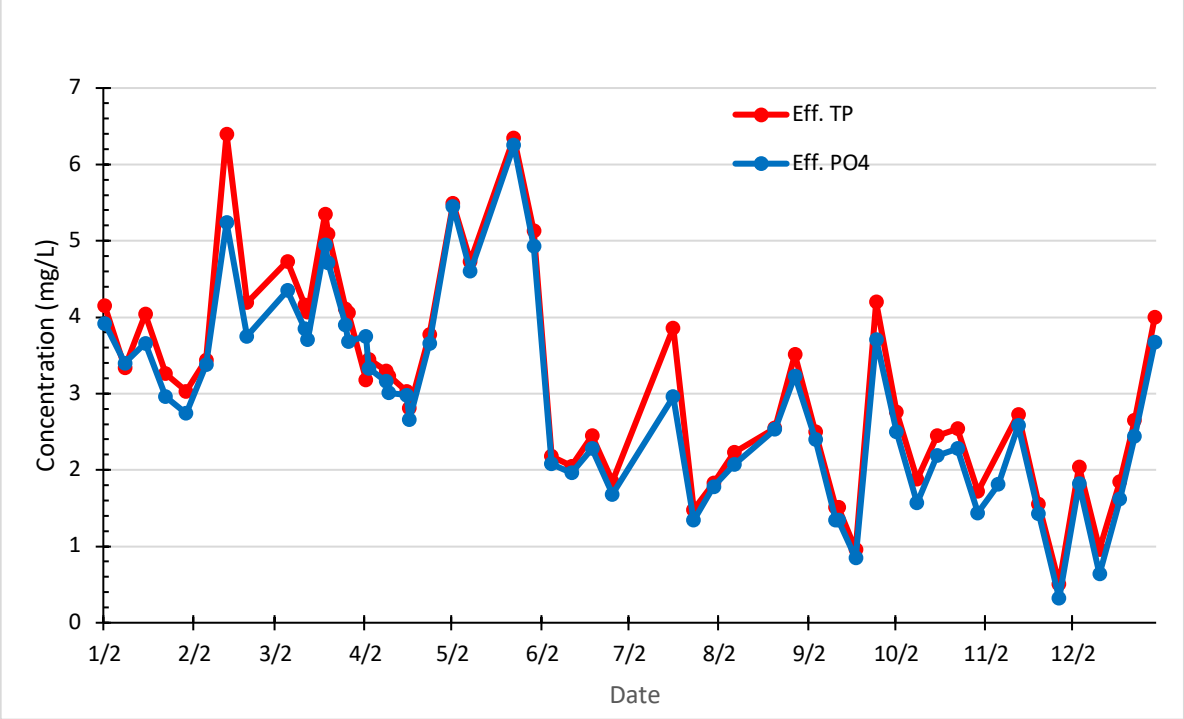


Figure 3. Results of Phosphorus Removal using Aluminum Salts

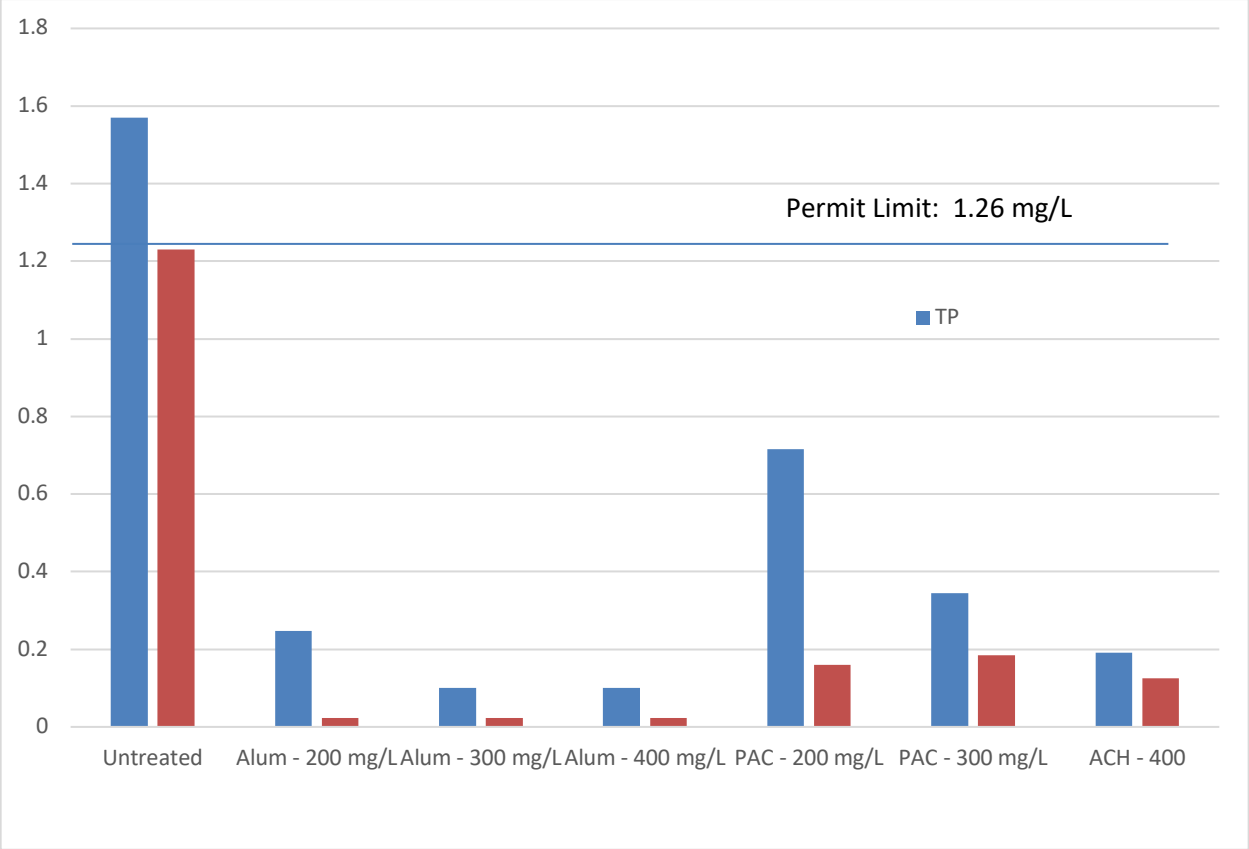


Table 1. Phosphorus Removal with Aluminum Salts

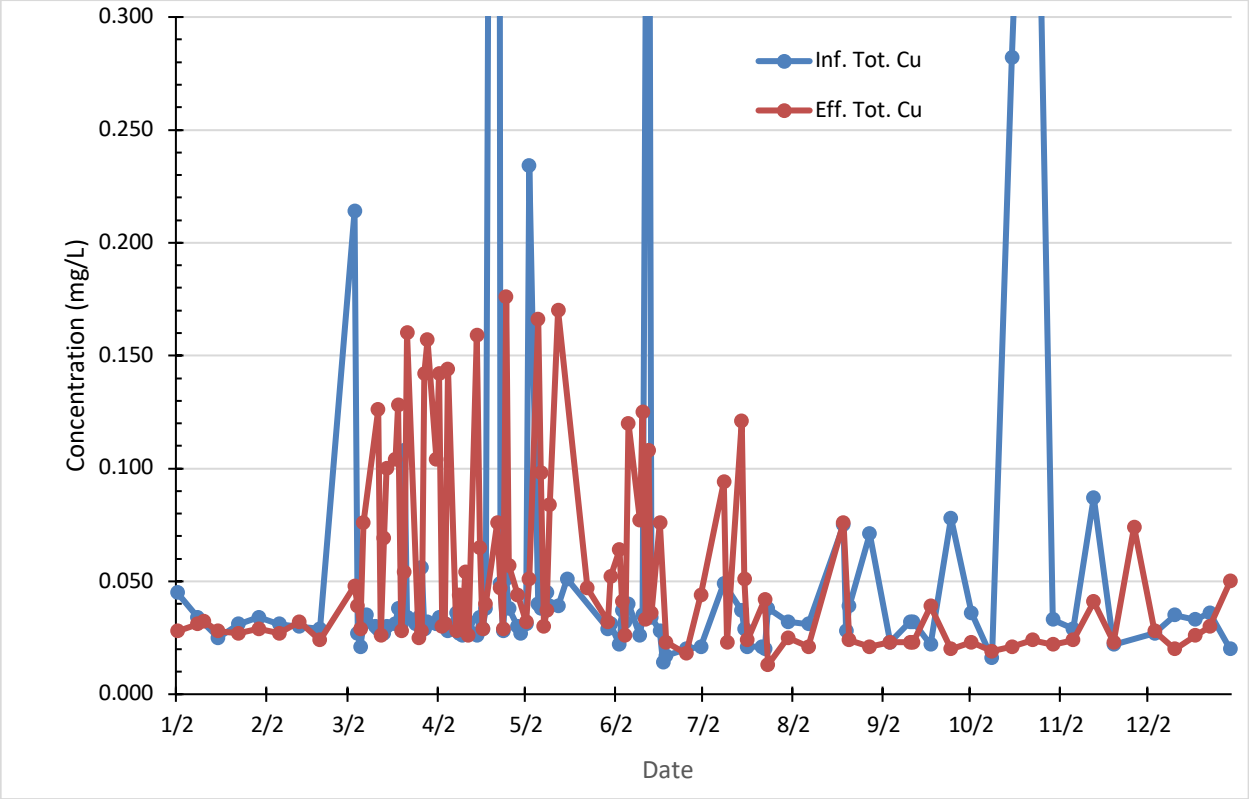
	TP	PO_4
Untreated	1.57	1.23
Alum - 200 mg/L	0.248	<0.023
Alum - 300 mg/L	<0.1	<0.023
Alum - 400 mg/L	<0.1	<0.023
PAC - 200 mg/L	0.715	0.16
PAC - 300 mg/L	0.345	0.184
ACH - 400	0.192	0.125

During 2020, additional work is planned to confirm these results and to evaluate removal at lower dosages. Work will also be done to determine the engineering requirements for implementation of chemical treatment for phosphorus reduction.

Copper

Currently, Barnhardt is required to only report effluent total copper (Cu) concentrations. However, the limit of 22 µg/L will be in effect at the end of the compliance period. Influent and effluent total copper concentrations are shown in Figure 4. This data was collected for monitoring purposes and are shown in Appendix B. The average influent Cu concentration was 63 µg/L and the average effluent concentration was 56 µg/L. Effluent concentrations were more stable at the end of 2019 with values often below 30 µg/L.

Figure 4. Influent and Effluent Total Copper Concentrations



Copper analyses were performed during the phosphorus removal chemical treatment trials noted above to determine if any insoluble forms of copper would be removed. However, no significant copper removal was observed.

In December 2018, the Quality Assurance Project Plan (QAPP) was submitted to MassDEP for conducting water quality monitoring to be used in a Biotic Ligand Model (BLM) to further assess the site-specific copper criteria used to establish the Barnhardt permit limit. Sampling was begun in May 2019. Results through December are shown in Appendix C. Testing is

scheduled to be completed in the Spring of 2020. Based on the model results, the need for copper removal from the effluent will be further evaluated.

Additional testing is planned in 2020 to evaluate methods of effluent copper removal in the event that the BLM does not provide a site-specific limit that will not require further treatment. These efforts will include treatment and source reduction options.

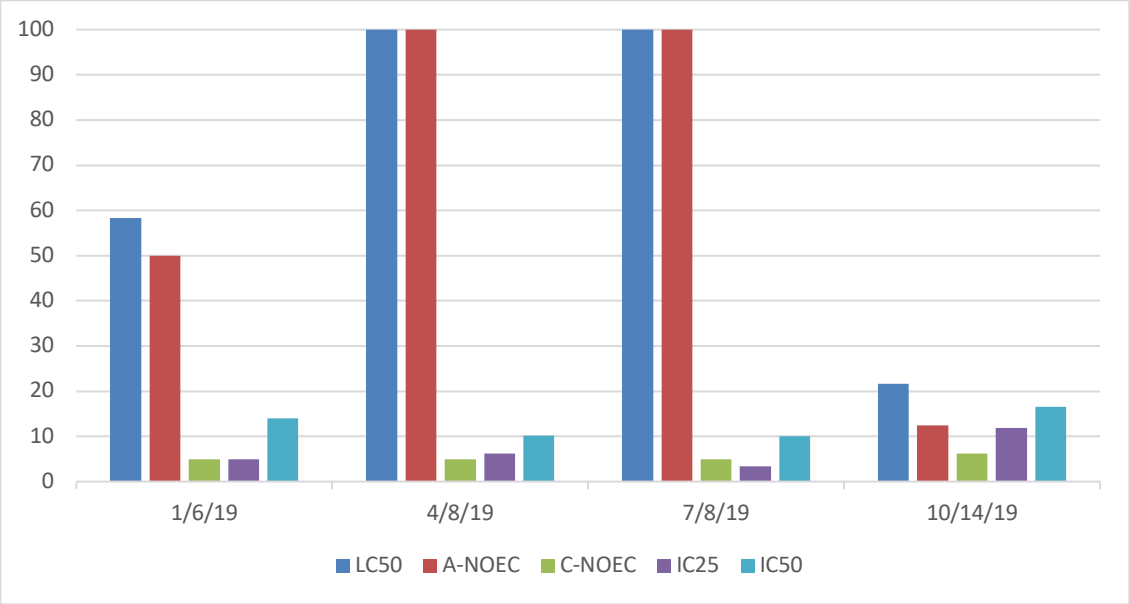
Toxicity

Currently, the permit limit for acute toxicity is an LC_{50} of >100% and for chronic toxicity the limit is a chronic No Observed Effect Concentration (C-NOEC) of >5%. At the end of the compliance period the C-NOEC becomes more restrictive with a limit of >7.2%. The 2019 test results are shown in Table 3 and Figure 5.

Table 3. 2019 Toxicity Test Results

	LC50	A-NOEC	C-NOEC	IC25	IC50
Permit Limits:	>100%		>5%		
Date					
1/6/19	58.3	50	<5	4.9	14
4/8/19	100	100	<5	6.2	10.2
7/8/19	100	100	<5	3.35	10
10/14/19	21.6	12.5	6.25	11.9	16.6

Figure 5. 2019 Toxicity Test Results



Note that the 5% LC_{50} values shown in Figure 5 actually represent values of <5% and were not in compliance with the current permit. Acute toxicity levels exceeded (were more toxic) the permit limit during January and October quarters while the chronic limit was exceed for January, April, and July quarters. IC_{25} values are consistent with the C-NOEC values. All of the chronic values exceeded the pending limit 7.2%.

In an effort to better understand the cause of toxicity, acute and chronic testing was performed on an effluent sample with the following additional treatment:

1. Activated carbon to remove dissolved organics;
2. Membrane filtration (0.045µm) to remove colloidal and suspended solids;
3. EDTA treatment to chelate copper and other metals; and
4. Chemical Coagulation using PAC.

Unfortunately, none of these treatments significantly improved the toxicity when compared to the untreated sample. There is concern that trace levels of herbicide or pesticides are present as contaminates on the cotton and are being removed during the scouring process. These compounds may be highly toxic and resistant to biodegradation or biodegrade into more toxic by-products.

Additional work is proposed to identify the cause of the toxicity or to identify treatment alternatives. Chemicals used in manufacturing have been evaluated and one of the scouring agents is being replaced due to its relatively high concentration of aromatic compounds. Toxicity testing is being considered for other manufacturing chemicals. Testing is also proposed to evaluate for the presence of trace levels of pesticides or herbicides that may be present on the raw cotton. In terms of treatment alternatives, additional testing is proposed to further evaluate the use of activated carbon, advanced oxidation and other treatments including those outlined in the EPA Aquatic Toxicity Identification Evaluation (TIE) protocols.[1,2,3]

Conclusion

In conclusion, work has been completed and is on-going to evaluate methods for compliance with the phosphorus, copper and toxicity limits. Compliance with the phosphorus limit appears to be achievable by precipitation with alum. In the event that the BLM does not justify higher site-specific limits for copper resulting in permit compliance, additional chemical treatment or source reduction may be needed for this parameter. Available methods are being evaluate. Toxicity reduction is the most challenging issue in that toxicity was not reduced using enhanced treatment such as activated carbon. In addition, the toxicity may be caused by trace levels of toxicants such as herbicides or biocides or oxidation by-products. TIE protocols are proposed to

[1] USEPA (1991). Methods for Aquatic Toxicity Identification Evaluations: Phase I Toxicity Characterization Procedures. EPA/600/6-91/003.
[2] USEPA (1993). Methods for Aquatic Toxicity Identification Evaluations: Phase II Toxicity Identification Procedures for Samples Exhibiting Acute and Chronic Toxicity. EPA-600/R-92/080.
[3] USEPA (1993). Methods for Aquatic Toxicity Identification Evaluations: Phase III Toxicity Confirmation Procedures for Samples Exhibiting Acute and Chronic Toxicity. EPA-600/R-92/081.

further evaluate toxicity. Work will continue into 2020 in an effort to be in compliance with the permit limits as required by the compliance schedule.

If you have any questions or need additional information, please feel to contact me or either Mr. Tom Robinson or Mr. Greg Morand at the numbers shown below.

Tom Robinson, Barnhardt Mfg., Phone: 704-376-0380

Greg Morand, Omni Environmental, Phone: 978-256-6766, Ext. 102

Sincerely,

W. Gilbert O'Neal, Ph.D., P.E.
President

Cc: Greg Morand, Omni Environmental Group
Tom Robinson, Barnhardt Mfg.
Lewis Barnhardt, Barnhardt Mfg.

Appendix A. 2019 Phosphorus Data

SampleDate	Inf. TP	Eff. TP	Inf. PO4	Eff. PO4
1/2/2019	6.95	4.15	2.12	3.92
1/9/2019	5.02	3.34	3	3.4
1/16/2019	6	4.04	3.68	3.66
1/23/2019	6.1	3.26	3.74	2.96
1/30/2019	6.07	3.03	3.56	2.74
2/6/2019	8.36	3.44	6.16	3.38
2/13/2019	7.12	6.4	4.28	5.24
2/20/2019	7.7	4.19	4.72	3.75
3/6/2019	3.78	4.73	2.24	4.35
3/12/2019	7.46	4.16	5.75	3.85
3/13/2019	5.3	4.07	3.51	3.71
3/19/2019	10.8	5.35	7.55	4.95
3/20/2019	4.99	5.09	2.97	4.71
3/26/2019	4.81	4.11	2.9	3.9
3/27/2019	3.99	4.06	2.24	3.68
4/2/2019	5.87	3.18	3.9	3.75
4/3/2019	8.41	3.45	5.85	3.33
4/9/2019	6.09	3.3	4.18	3.16
4/10/2019	2.59	3.23	1.4	3.01
4/16/2019	2.77	3.03	1.76	2.98
4/17/2019	7.49	2.81	5.95	2.66
4/24/2019	5.37	3.77	3.51	3.66
5/2/2019	7.08	5.49	4.85	5.45
5/8/2019	7.76	4.73	4.88	4.6
5/16/2019	9.22		6.45	
5/23/2019		6.35		6.25
5/30/2019	6.21	5.13	4.55	4.93
6/5/2019	3.54	2.18	2.02	2.08
6/12/2019		2.05		1.96
6/19/2019	3.48	2.45	2.52	2.28
6/26/2019	4.77	1.85	3.75	1.68
7/17/2019	3.23	3.86	1.67	2.96
7/24/2019	7.3	1.48	5.3	1.34
7/31/2019	5.94	1.83	4.27	1.78
8/7/2019	7.18	2.23	5	2.07

SampleDate	Inf. TP	Eff. TP	Inf. PO4	Eff. PO4
8/14/2019	5.6		3.79	
8/21/2019	7.48	2.55	5.3	2.53
8/28/2019	4.2	3.51	2.86	3.23
9/4/2019	3.48	2.5	1.75	2.4
9/11/2019	6.49	1.51	5.2	1.34
9/12/2019	6.49	1.51	5.2	1.34
9/18/2019	4.28	0.955	3.69	0.847
9/25/2019	4.66	4.2	3.28	3.71
10/2/2019	2.23	2.76	1.02	2.5
10/9/2019	0.586	1.88	0.211	1.57
10/16/2019	5.67	2.45	3.58	2.19
10/23/2019	5.02	2.54	3.42	2.28
10/30/2019	5.06	1.72	3.1	1.44
11/6/2019	2.04		1.27	1.81
11/13/2019	6.88	2.73	3.57	2.58
11/20/2019	1.25	1.55	0.585	1.43
11/27/2019		0.509		0.319
12/4/2019	5.38	2.04	3.92	1.82
12/11/2019	4.61	0.959	0.62	0.637
12/18/2019	2.99	1.85	1.74	1.62
12/23/2019	0.503	2.65	0.1	2.44
12/30/2019	0.511	4	0.284	3.67
Average	5.26	3.15	3.42	2.91
Max.	10.80	6.40	7.55	6.25
Min.	0.50	0.51	0.10	0.32

Appendix B. Influent and Effluent Copper Data

SampleDate	Inf. Tot. Cu	Eff. Tot. Cu	Eff. Sol. Cu
1/2/2019	0.045	0.028	
1/9/2019	0.034	0.031	
1/11/2019		0.0324	
1/16/2019	0.025	0.028	
1/23/2019	0.031	0.027	
1/30/2019	0.034	0.029	
2/6/2019	0.031	0.027	
2/13/2019	0.03	0.032	
2/20/2019	0.029	0.024	
3/4/2019	0.214	0.048	
3/5/2019	0.027	0.039	
3/6/2019	0.021	0.029	
3/7/2019	0.031	0.076	
3/8/2019	0.035		0.057
3/11/2019	0.03		0.164
3/12/2019	0.029	0.126	
3/13/2019	0.028	0.026	
3/14/2019	0.027	0.069	
3/15/2019	0.03	0.1	
3/18/2019	0.031	0.104	
3/19/2019	0.038	0.128	
3/20/2019	0.031	0.028	
3/21/2019	0.108	0.054	
3/22/2019	0.034	0.16	
3/25/2019	0.031		0.034
3/26/2019	0.034	0.025	
3/27/2019	0.056	0.028	
3/28/2019	0.029	0.142	
3/29/2019	0.032	0.157	
4/1/2019	0.031	0.104	
4/2/2019	0.034	0.142	
4/3/2019	0.032	0.03	
4/4/2019	0.031	0.031	
4/5/2019	0.028	0.144	
4/8/2019	0.036	0.028	
4/9/2019	0.027	0.044	

SampleDate	Inf. Tot. Cu	Eff. Tot. Cu	Eff. Sol. Cu
4/10/2019	0.026	0.029	0.027
4/11/2019	0.032	0.054	
4/12/2019	0.032	0.026	
4/15/2019	0.026	0.159	
4/16/2019	0.034	0.065	0.065
4/17/2019	0.029	0.029	
4/18/2019	0.038	0.04	
4/22/2019	1.36	0.076	
4/23/2019	0.049	0.047	
4/24/2019	0.028	0.029	
4/25/2019	0.051	0.176	
4/26/2019	0.038	0.057	
4/29/2019	0.03	0.044	
4/30/2019	0.027		0.146
5/2/2019	0.031	0.032	0.034
5/3/2019	0.234	0.051	
5/6/2019	0.04	0.166	
5/7/2019	0.038	0.098	
5/8/2019	0.038	0.03	
5/9/2019	0.045	0.037	
5/10/2019	0.039	0.084	
5/13/2019	0.039	0.17	
5/16/2019	0.051		
5/23/2019		0.047	
5/30/2019	0.029	0.032	
5/31/2019	0.031	0.052	
6/3/2019	0.022	0.064	
6/4/2019	0.037	0.041	
6/5/2019	0.032	0.026	
6/6/2019	0.04	0.12	
6/10/2019	0.026	0.077	
6/11/2019	0.035	0.125	
6/12/2019		0.033	0.032
6/13/2019	0.539	0.108	
6/14/2019	0.034	0.036	
6/17/2019	0.028	0.076	
6/18/2019	0.014		
6/19/2019	0.017	0.023	0.021

6/26/2019	0.02	0.018	0.016
7/1/2019	0.021	0.044	
7/9/2019	0.049	0.094	
7/10/2019		0.023	
7/15/2019	0.037	0.121	
7/16/2019	0.029	0.051	
7/17/2019	0.021	0.024	0.023
7/22/2019	0.021		0.058
7/23/2019	0.02	0.042	
7/24/2019	0.038	0.013	0.017
7/31/2019	0.032	0.025	
8/7/2019	0.031	0.021	
8/19/2019	0.075	0.076	
8/20/2019	0.028		0.124
8/21/2019	0.039	0.024	0.022
8/28/2019	0.071	0.021	
9/4/2019	0.023	0.023	
9/11/2019	0.032	0.023	
9/12/2019	0.032	0.023	
9/18/2019	0.022	0.039	0.034
9/25/2019	0.078	0.02	
10/2/2019	0.036	0.023	
10/9/2019	0.016	0.019	
10/16/2019	0.282	0.021	
10/23/2019	0.517	0.024	0.021
10/30/2019	0.033	0.022	0.022
11/6/2019	0.029	0.024	
11/13/2019	0.087	0.041	0.035
11/20/2019	0.022	0.023	0.019
11/27/2019		0.074	
12/4/2019	0.027	0.028	
12/11/2019	0.035	0.02	0.021
12/18/2019	0.033	0.026	0.027
12/23/2019	0.036	0.03	0.027
12/30/2019	0.02	0.05	0.046
Average	0.063	0.056	0.046
Max.	1.360	0.176	0.164
Min.	0.014	0.013	0.016

Appendix C. BLM Data

LABORATORY ANALYTICAL RESULTS (units in mg/L unless otherwise shown)												FIELD PARAMETERS							
Sample ID	Sample Date	Suspended Solids		Sulfate		Chloride		Total Alkalinity		Dissolved Organic Carbon		Turbidity (NTU)		Temperature (°C)		Specific Conductivity (µS/cm)		pH (Units)		Dissolved Oxygen (mg/L)	
Upstream	5/8/2019	5	U	3.9		6.5		22		1.9		1	U	13.00		80		7.55		11.22	
	6/19/2019	2	U	3.5		6.8		22		2.5		1	U	18.00		81		6.42		8.55	
	7/22/2019	2	U	4.8		10		34		1.7		1	U	22.00		120		6.73		7.17	
	8/14/2019	2	U	4.8		10		35		1.8		1	U	21.00		120		6.95		7.65	
	9/17/2019	2	U	4.9		11		37		1.8		1	U	15.00		120		6.95		8.49	
	10/8/2019	2	U	4.9		10		34		1.9		1	U	14.00		120		7.11		8.40	
	11/5/2019	2	U	4.2		7.3		21		3.3		1	U	9.00		80		6.42		NA	
	12/19/2019	2.4		4.4		6.9		17		2.1		1		1.00		83		7.56		14.86	
Downstream	5/8/2019	5	U	4.4		6.7		31		2.5		1	U	16.00		100		7.60		8.66	
	6/19/2019	2	U	5.0		6.9		28		2.9		1	U	19.00		100		6.81		7.87	
	7/22/2019	2	U	8.1		11		89		4.7		1	U	22.00		240		7.55		7.65	
	8/14/2019	2	U	8.1		11		92		5.9		1	U	22.00		240		7.90		8.54	
	9/17/2019	2	U	12		11		68		3.8		1	U	17.00		200		7.88		8.63	
	10/8/2019	3		7.6		11		60		3.8		1.3		14.00		180		7.57		8.46	
	11/5/2019	2	U	5.0		7.7		34		4.3		1	U	9.00		110		6.57		NA	
	12/19/2019	2	U	5.3		7.0		25		2.6		2		1.00		100		7.24		14.70	
Effluent	5/8/2019	12		99		14		1,500		110		1		23.00		3,100		8.66		NM	
	6/20/2019	2.8		220		2.9		1,000		69		1.3		18.00		2,400		8.45		6.57	
	7/23/2019	4.6		53		14		830		53		1.3		11.00		1,700		8.35		9.26	
	8/15/2019	5.4		77		22		1,200		90		1.8		11.00		2,500		8.73		8.10	
	9/18/2019	11		230		21		970		61		3		11.00		2,300		8.60		4.88	
	10/9/2019	23		110		23		1,100		71		7.4		7.00		2,400		8.65		8.82	
	11/6/2019	24		7.0		1.6		1,000		75		7		4.00		2,200		8.75		NA	
	12/19/2019	28		130		17		1,100		97		10		3.00		2,600		8.54			
Duplicate	5/8/2019	5	U	4.5		6.6		31		2.5		1	U	NA		NA		NA		NA	
	6/19/2019	2	U	4.9		7.0		29		3.0		1	U	NA		NA		NA		NA	
	7/22/2019	2	U	8.2		11		89		4.6		1	U	NA		NA		NA		NA	
	8/14/2019	2.2		8.1		11		93		6.0		1	U	NA		NA		NA		NA	
	9/17/2019	2	U	12		11		68		3.7		1	U	NA		NA		NA		NA	
	10/8/2019	2.2		7.7		11		59		3.8		1.2		NA		NA		NA		NA	
	11/5/219	2	U	5.1		7.7		34		4.1		1	U	NA		NA		NA		NA	
	12/19/2019	2	U	5.3		7.0		26		2.6		2		NA		NA		NA		NA	

NOTES:
NTU = Nephelometric Turbidity Units
mg/L = Milligrams per liter
U = Not detected by laboratory in concentration at or above reporting limit that is presented in previous column
(µS/cm) - Micro Siemens per centimeter
(mV) - Millivolts
NA - Not Applicable
NM - Not Measured

LABORATORY ANALYTICAL RESULTS (mg/L)									
Sample ID	Sample Date	Calcium	Dissolved Copper	Total Copper	Magnesium	Potassium	Sodium	Total Hardness
Upstream	5/8/2019	9.1	0.0007	0.0005	0.98	1.0	5.0	27
	6/19/2019	8.5	0.0009	0.0008	1.3	0.96	5.4	27
	7/22/2019	14	0.0010	0.0008	1.5	1.7	7.3	40
	8/14/2019	13	0.00074	0.00068	1.5	1.6	7.4	39
	9/17/2019	13	0.0007	0.00065	1.6	1.6	7.9	40
	10/8/2019	13	0.00055	0.00063	1.5	1.7	7.1	39
	11/5/219	8.3	0.00067	0.00085	1.1	1.3	5.3	26
	12/19/2019	8.5	0.00069	0.00084	1.0	1.0	4.7	25
Downstream	5/8/2019	9.2	0.0021	0.0007	1.0	1.6	11	27
	6/19/2019	8.6	0.0009	0.0009	1.3	1.3	8.6	27
	7/22/2019	14	0.0017	0.0016	1.7	4.0	36	41
	8/14/2019	13	0.0021	0.0017	1.7	4.3	36	40
	9/17/2019	14	0.0014	0.0014	1.8	3.6	30	43
	10/8/2019	14	0.0023	0.0011	1.7	2.9	21	41
	11/5/219	8.6	0.0011	0.0012	1.2	2.0	11	26
	12/19/2019	8.9	0.00097	0.00086	1.0	1.3	8.1	26
Effluent	5/9/2019	20	0.022	0.022	8.8	82	780	87
	6/20/2019	14	0.016	0.016	5.9	47	510	59
	7/23/2019	17	0.011	0.013	5.1	37	400	64
	8/15/2019	19	0.016	0.018	7.5	62	600	79
	9/18/2019	19	0.014	0.015	7.1	54	570	76
	10/9/2019	12	0.015	0.018	7.2	58	570	59
	11/6/2019	14	0.016	0.019	7.2	66	530	65
	12/19/2019	6.7	0.019	0.019	7.6	74	590	48
Duplicate	5/8/2019	9.0	0.0015	0.0007	1.0	1.6	10	27
	6/19/2019	8.6	0.0009	0.0009	1.3	1.2	8.6	27
	7/22/2019	14	0.0016	0.0017	1.7	3.9	36	41
	8/14/2019	13	0.0017	0.0018	1.7	4.5	37	40
	9/17/2019	14	0.0014	0.0017	1.8	3.6	30	43
	10/8/2019	14	0.0014	0.0013	1.8	2.9	21	43
	11/5/219	8.4	0.00097	0.00090	1.2	2.0	11	26
	12/19/2019	8.8	0.00010	0.00013	1.1	1.4	8.2	26

NOTES:
mg/L = Milligrams per liter
U = Not detected by laboratory in concentration at or above reporting limit that is presented in previous column